ISSN 0103-5150
Fisioter. Mov., Curitiba, v. 26, n. 4, p. 813-820, set./dez. 2013

doi: 10.1590/S0103-51502013000400010

Does usual practice of physical activity affect balance in elderly women?

Prática habitual de atividade física afeta o equilíbrio de idosas?

Eliane Regina Ferreira Sernache de Freitas[a], Fernando Raphael Pinto Guedes Rogério[b], Cárita Mayume Yamacita[c], Mayara de Luca Vareschi[d], Rubens Alexandre da Silva[e]

[a] Physiotherapist, specialist in Exercise Physiology from Universidade Norte do Paraná (UNOPAR), Londrina, PR - Brazil, e-mail: fernandopintoguedes@hotmail.com
[b] Physiotherapist, specialist in Manual and Postural Therapeutic Resources from the State University of Londrina (UEL), Londrina, PR - Brazil, e-mail: caritayamacita@gmail.com
[c] Physiotherapist, specialist in Manual and Postural Therapeutic Resources from UEL, Londrina, PR – Brazil, e-mail: mayara.vareschi@unopar.br
[d] Post-Ph.D in Health Sciences from the University of Montreal, professor at UNOPAR, Londrina, PR - Brazil, e-mail: rubensalex@hotmail.com
[e] Ph.D in Health Sciences from the Federal University of São Paulo (UNIFESP), physiotherapist and Technical Supervisor at Irmandade da Santa Casa de Londrina (ISCAL), professor at UNOPAR, Londrina, PR - Brazil, e-mail: elianefe@sercomtel.com.br

Abstract

Introduction: The systems responsible for maintaining postural control naturally went into decline with advancing age, something which may compromise the ability to keep posture within the stability limits, influencing on the balance of body structures and increasing the risk of falls. **Objective**: Check the impact of the usual practice of physical activity on stabilographic parameters, and the static and dynamic balance of physically independent elderly people. **Materials and methods**: This is a cross-sectional and descriptive study. The sample consisted of 77 women aged from 60 to 75 years, stratified into 5 groups according to the physical activity classified by means of the international Physical Activity Questionnaire (IPAQ). We used strength platform for stabilographic evaluation, one-foot standing test (static balance), and the time up and go test (dynamic balance). **Results**: We observed statistically significant differences in all stabilometric parameters analyzed, except in the oscillation speed in the X axis. On the other hand, the results regarding functional tests showed no significant difference among the groups, however, for the time up and go test we identified a tendency to good functional mobility with an increase in the usual practice of physical activity. **Conclusion**: The increased usual practice of physical activity represents and improved body stability quantified by means of stabilometry, a fact not shown in the neuromotor tests.

Keywords: Aging. Postural balance. Physical activity. International Physical Activity Questionnaire.

Resumo

Introdução*: Os sistemas responsáveis pela manutenção do controle postural naturalmente entram em declínio com o avanço da idade, o que pode comprometer a capacidade de manter a postura nos limites de estabilidade, influenciando no equilíbrio das estruturas corporais e, consequentemente, aumentando os riscos de quedas.* ***Objetivo****: Verificar o impacto da prática habitual de atividade física sobre os parâmetros estabilográficos, equilíbrio estático e dinâmico de idosos fisicamente independentes.* ***Materiais e métodos****: Trata-se de um estudo transversal e descritivo. A amostra foi composta de 77 mulheres com idade entre 60 a 75 anos estratificadas em cinco grupos de acordo com a prática de atividade física classificada pelo International Physical Activity Questionnaire (IPAQ). Foi utilizada a plataforma de força para avaliação estabilográfica, Teste de Apoio Unipodal (TAU) — equilíbrio estático, e o Timed Up and Go (TUG) — equilíbrio dinâmico.* ***Resultados****: Foram observadas diferenças estatisticamente significantes em todos os parâmetros estabilométricos analisados exceto na velocidade de oscilação no eixo X. Por outro lado, os resultados referentes aos testes funcionais não apresentaram diferenças significativas entre os grupos, entretanto, para o TUG verificou-se uma tendência à boa mobilidade funcional com o aumento da prática habitual de atividade física.* ***Conclusão****: A prática habitual de atividade física mais elevada representa melhora na estabilidade corporal quantificada pela estabilometria, fato este não demonstrado nos testes neuromotores.*

Palavras chave*: Envelhecimento. Equilíbrio postural. Atividade física. IPAQ.*

Introduction

Demographic aging is well established in developed countries and it has enjoyed an increasing growth in developing countries, such as Brazil. It is estimated that by 2025 Brazil will have the 6th largest elderly population. This phenomenon inevitably leads to an increased prevalence of chronic degenerative diseases (1), prompting an increased demand for health services, with hospitalizations and the use of different kinds of high-cost interventions, being characterized as a public health problem (2).

The aging process is associated to different physiological and morphological changes in the musculoskeletal system, being characterized as a decreased muscle performance noticed in an elderly person's physical/motor fitness and functional capacity. Due to the senescence process, changes in motor performance may increase the risk of falls among the elderly population (3).

Falls are currently regarded as a major health problem in the elderly people. Around 1/4 of the population over 65 years has already experienced a situation involving fall and 60% of these individuals were exposed to a lesion in the musculoskeletal system (4).

Among the most common causes of falls we highlight postural instability (5). The senescence process leads to impairment of the postural control system, either static or dynamic. In fact, the systems responsible for maintaining postural control naturally begin to decline as the chronological age increases, decreasing our ability to keep posture within the safety limits, thus influencing on the balance of body structures and also on the risk of falls (6).

The adaptations arising from the usual practice of physical activity contribute to the maintenance, improvement, and decrease in the functional decline caused by the senescence process, besides contributing to good postural control and decreasing the risk of falls among this population (7). The close relationship between the usual practice of physical activity and health indicators among the elderly population leads to a continued incentive to promote this practice (8).

Among the methods for assessing the usual practice of physical activity by an individual, the International Physical Activity Questionnaire (IPAQ), long version, constitutes a simple and practical instrument to address the physical activities practiced in the last week in the domains labor, transportation, leisure, and domestic activities (9).

However, little is known about the impact that the practice of physical activity by an elderly person has on her/his ability to keep postural control. Some studies show that elderly people participating in programs of usual physical activity have better balance when compared to sedentary elderly people (10, 12). However, it would be interesting to identify what physical activity level could classify the elderly person as having a good postural control.

This study aimed to check the impact of usual physical activity on postural control among physically independent elderly people.

Methods

Subjects

We included individuals ≥ 60 years of age participating in a community physical activity program, who had no neuromuscular, vestibular, or visual pathologies, a recent fracture or the use of prosthesis at the lower ends and they volunteered to participate in this study. All elderly people were informed about the study objectives and the procedures adopted for data collection and, once aware of these, they signed a free and informed consent term form agreeing to participate. The study was approved by the Research Ethics Committee of Universidade Norte do Paraná, under the Protocol 0040/09.

Data collection

Usual practice of physical activity

For classifying the individuals with regard to the practice of physical activity, we used the IPAQ, long version (9). This was applied as an interview, by an only previously trained evaluator, with no time limit for its completion. According to the instructions of the questionnaire itself, we calculated the individual scores by stratifying the elderly people into 5 groups: 1) sedentary (ST), those who have not met the minimum recommendation criteria; 2) active (AT), individuals who met the recommendation to practice vigorous physical activity ≥ 3 days per week with ≥ 20 minutes/session or frequency ≥ 5 days/week lasting ≥ 30 minutes/session of moderate physical activity or walking, as well as any other activity practiced at a frequency ≥ 5 days/week and length ≥ 150 minutes/week (moderate to vigorous walking); 3) very active (VA), those who met the recommendation to practice vigorous physical activity at a frequency ≥ 5 days/week and length ≥ 30 minutes/session, practice 3 days/week and length ≥ 20 minutes/session of moderate activity; frequency ≥ 5 days/week and length ≥ 30 minutes/session; 4) insufficiently active A (ISF-A), those who achieved at least one criteria of the recommendation, with frequency of 5 days/week of physical activity or duration of 150 minutes/week; and 5) insufficiently active B (ISF-B), those who did not meet any criteria of the recommendation.

Postural control (stabilometry)

For assessing postural control through stabilometry, we used the pressure platform *Eclipse 3000* – Guy-Capron, S.A., France (1,600 sensors and 6,400 set points), calibrated to obtain the filtered signals and with a sampling frequency of 10 Hz. The platform data were subsequently analyzed using the software *Podosat*, version 5.0, for identifying postural control measures: total area of the pressure center (PC) and the average quadratic speed of PC displacement in the frontal and sagittal sections.

Prior to testing, the individuals remained seated at rest for 5 minutes and, then, they were allocated to a quiet room for familiarization with the pressure platform and the experimental protocol. Subsequently, the individuals were positioned standing on the platform (two-feet support), being barefoot, static, and relaxed, with arms along the body and the eyes open and aiming at a point located at the height of her/his eyes 1 meter and a half away. The protocol consisted in keeping this position for 60 s.

Risk of fall and functional mobility

For assessing the risk of fall and the functional mobility in elderly people, we used the time up and go (TUG) test (13). Functional mobility was quantified with regard to the time (s) that the individual took to get up from a standardized chair, walk for 3 m and return to the sitting position.

The test began at the starting signal, simultaneously represented by the evaluator bending her/his left arm and saying her/his verbal command, and it finished after the elderly person returned to the initial position, sitting with his back against the chair. Thus, the elderly people were classified as having: 1) good mobility, represented by the elderly people who started by themselves with no assistance or resource and completed the pathway in ≤ 10 s; 2) normal mobility, those who completed the pathway between 11 and 20 s; and 3) dependence for mobility, those taking > 20 s, who could not go out alone, and needed some resource for walking; these individuals were excluded from the study.

Balance with the one-foot standing test

The one-foot standing test (OST) was performed to evaluate the static balance status with one-foot support under two conditions, the first with open eyes (OE) and the second with closed eyes (CE). This test is generally used to quantify balance, although representing an indirect measurement test for healthy individuals (14). During the test, the individual had to stand on the dominant limb with OE and subsequently with CE for, at most, 30 s. The time for which she/he managed to stay supported only on an only foot was measured at 3 attempts in each situation (OE and CE) and the best out of the three attempts was considered for determining her/his performance. Our study took into account the time between 21 and 30 s in order to classify the elderly person as having no change in balance, according to data proposed in the literature (15).

Statistical analysis

Data analysis was performed by calculating the median and interquartile range. For checking data normality, we performed the Kolmogorof-Smirnoff test, and, since data distribution was not Gaussian, we resorted to non-parametric statistics by means of the Kruskal-Wallis test, followed by post-hoc Dunn to compare the stabilographic variables from the evaluation on the strength platform and OST in the various groups classified by means of IPAQ. Fischer's exact test was used to compare TUG scores between groups. The significance level adopted for statistical tests was 5% ($p < 0.05$). All statistical analyzes were performed using the softwares *Statistical Package for the Social Sciences* (SPSS), version 17.0, and *BioEstat*, version 5.0.

Results

We evaluated 77 women, with a mean age of 64.7 ± 8.2 years. Data on the demographic variables of elderly women, subdivided into the 5 groups according to the usual practice of physical activity, are shown in Table 1.

Regarding the prevalence of usual practice of physical activity, we observed that 55.8% of the elderly women met the recommendation to practice physical activity on a daily basis; 35.0% of them were classified as active and 20.8% as very active.

Among the very active elderly women, 81.2% were married and 62.5% reported having a good health status, while among the active ones 70.4% were married and 55.6% also regarded themselves as enjoying a good health status.

Overall, our findings indicated a significant impact ($p < 0.05$) of usual physical activity on postural control among the elderly women evaluated (Table 2), thus showing that sedentary elderly women showed higher postural instability when compared to their physically active counterparts. The only stabilographic variable showing no statistically significant difference between the physical activity domains was the speed of PC displacement in the Y axis ($p = 0.209$).

On the other hand, the results for neuromotor tests of static and dynamic balance showed no significant differences between the groups analyzed (OST with OE and CE and TUG) (Table 3).

Discussion

Our results showed a significant improvement in stabilometric parameters among elderly women with higher level of physical activity practice (active and very active), when compared to their less active counterparts. These results reaffirmed the importance of adequate levels of physical activity for keeping and improving the indicators responsible for the postural control system integrity.

Although the senescence process may be associated to decreased levels of usual practice of physical activity (16), an increase in these levels is a way to prevent falls among elderly people. Sedentary lifestyle accentuates the decline in bodily functions, leading to muscle weakness, decreased flexibility, degeneration of synergies and programming mechanisms, and changes in motor control, thus facilitating postural instability and contributing to falls. In contrast, a

Table 1 – Demographic variables and classification of the usual practice of physical activity of elderly people

Group	ST (n: 14 – 18,2%)	ISF-A (n: 10 – 13,0%)	ISF-B (n: 10 – 13,0%)	AT (n: 27– 35,0%)	MA (n: 16 – 20,8%)	TOTAL (N = 77 100,0%)	p
Age (mean ± SD)	65.6 ± 5.6	68.7 ± 11.0	62.4 ± 7.5	63.7 ± 8.8	64.7 ± 7.5	64.7 ± 8.2	ns
BMI (Kg\m²) (mean ± SD)	26.2 ± 3.8	23.4 ± 2.9	25.9 ± 4.7	25.9 ± 3.5	27.1 ± 4.5	25.8 ± 4.1	ns
Marital status							
Married n (%)	11 (78.6)	06 (60.0)	6 (60.0)	(70.4)	(81.2)	(71.4)	ns
Single n (%)	00 (0.0)	02 (20.0)	02 (20.0)	02 (74.1)	01 (6.3)	07 (9.1)	ns
Others n (%)	03 (21.4)	02 (20.0)	02 (20.0)	06 (22.2)	02 (12.5)	15 (19.5)	ns
Health perception							
Good n (%)	06 (42.9)	04 (40.0)	03 (30.0)	15.0 (55.6)	10 (62.5)	38 (49.4)	ns
Regular n (%)	08 (57.1)	06 (60.0)	06 (60.0)	12.0 (40.7)	06 (37.5)	37 (48.1)	ns
Bad n (%)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	ns
Very bad n (%)	00 (0.0)	00 (0.0)	01 (10.0)	01 (3.7)	00 (0.0)	02 (2.6)	ns

Legend: ST = sedentary; ISF-A = insufficiently active A; ISF-B = insufficiently active B; AT = active; VA = very active; ns = not significant; BMI = body mass index; SD = standard deviation.
Source: Research data.

Table 2 – Stabilographic parameters of platform presented as mean and standard deviation according to the physical activity practice level

Variables	ST (n 14 – 18,2%)	ISF-A (n 10 – 13,0%)	ISF-B (n 10 – 13,0%)	AT (n 27 – 35,0%)	MA (n 16 – 20,8%)	P
Oscillation amplitude of PC in the X axis (mm)	22.5*– 12.7	24.5 – 14.2	36.5* – 27.7	16.0* – 10.0	21.5* – 12.2	0.007
Oscillation amplitude of PC in the Y axis (mm)	18.0 – 6.4	28.0 – 13.6	25.0 – 48.7	17.0 – 10.0	18.05 – 14.5	0.012
PC speed in the X axis (mm/s)	19.35* – 7.5	19.05* – 9.0	21.75* – 9.4	11.2* – 6.0	12.65* – 6.8	0.005
PC speed in the Y axis (mm/s)	12.4 – 6.5	17.8 – 9.6	16.8 – 12.8	10.7 – 6.9	14.65 – 13.7	0.209
Displacement area of PC (mm²)	153.0 – 149.7	124.0 – 242.5	280.5* – 217.7	89.0* – 67.5	120.0 – 126.5	0.029
Average quadratic speed (mm/s²)	21.35* – 13.2	31.2* – 15.7	31.75* – 16.9	18.4* – 15.8	18.2* – 11.6	0.023

Legend: ST = sedentary; ISF-A = insufficiently active A; ISF-B = insufficiently active B; AT = active; VA = very active; PC = pressure center.
Source: Research data.

high level of physical activity practice is an effective strategy to prevent falls, considering the neuromuscular adaptations and motor control generated by this practice (17).

The sedentary lifestyle which tends to accompany the senescence process constitutes a strong risk factor for chronic degenerative diseases (17). Adopting a usual practice of physical exercise not only contributes to fight sedentary lifestyle, in order to keep the physical fitness components at satisfactory levels with regard to their health and functional capacity aspects, it also helps adhering to healthy habits and an active lifestyle. The literature claims that a large part of the deleterious effects attributed to aging is due, in fact, to sedentary lifestyle, which favors the low activation of physiological functions, causing immobility and disuse, instead of advancing years or the emergence of chronic diseases prevailing in this age group (18).

In this study, the elderly people with lower levels of usual practice of physical activity showed greater

Table 3 – Results for the functional test one-foot standing, with open eyes and closed eyes, and time up and go for each group

	ST (n: 14 – 18,2%)	ISF-A (n:10 – 13,0%)	ISF-B (n: 10 – 13,0%)	AT (n: 27 – 35,0%)	VA (n: 16 – 20,8%)	Total (N: 77 - 100,0%)	P
One-foot standing test with open eyes							
Median and interquartile range	22.2 – 7.9	24.3 – 6.3	26.1 – 9.7	26.9 – 6.2	26.9 – 4.4	25.6 – 7.9	0.295
Normal: 21 – 30 seg. – n (%)	10 (71.4)	07 (70.0)	07(70.0)	23 (85.2)	13 (81.2)	60 (77.9)	0.550
Decreased ≤ 20 seg. – n (%)	04 (28.6)	03 (30.0)	03 (30.0)	04 (14.8)	03 (18.8)	17 (22.1)	0.750
One-foot standing test with closed eyes							
Median and interquartile range	8.7 – 6.8	11.1 – 10.7	10.8 – 4.5	12.1 – 8.9	13.4 – 11.7	12.0 – 10.0	0.660
Normal: 21 – 30 seg. – n (%)	02 (14.3)	00 (0.0)	01 (10.0)	06 (22.2)	03 (18.8)	12 (15.6)	0.579
Reduzido: ≤ 20 – n (%)	12 (85.7)	10 (100.0)	9 (90.0)	21 (77.8)	13 (81.2)	65 (84.4)	0.831
Timed up and go test							
Good mobility - n (%)	14 (100.0)	07 (70.0)	02 (20.0)	27 (100.0)	16 (100.0)	52 (67.5)	0.097
Normal - n (%)	00 (0.0)	03 (30.0)	08 (80.0)	00 (0.0)	00 (0.0)	25 (32.5)	0.068

Legend: ST = sedentary; ISF-A = insufficiently active A; ISF-B = insufficiently active B; AT = active; VA = very active; PC = pressure center; SD = standard deviation.
Source: Research data.

oscillation in stabilometric variables, mainly regarding oscillation amplitude and PC speed in the X axis (mediolateral), as well as in the PC displacement area and the PC average quadratic speed. This poorly evidenced fact, although already reported in the literature (19), that the speed of PC displacement significantly increases in individuals ≥ 60 years of age and the PC total oscillation area has significantly increased values for people ≥ 80 years, regardless of the physical activity level.

The decreased balance among elderly individuals may be explained through several mechanisms culminating in the reduction of vestibular, sensory, and neuromuscular function, as well as in a progressive loss of nerve cells, brain atrophy, and cell death, especially in the cerebellum cortex, hippocampus, substantia nigra, hypothalamic nuclei, dendritic changes, changes in motor units, and decreased muscle strength, explosive power, and muscle endurance. Changes observed in the sensory system of elderly people, as well as decreased proprioception, will act as an additional risk factor to fall, since the response of these individuals will take longer time, which, occasionally, may be insufficient to keep balance. Deterioration of the sensory system affects postural stability and, thus, there is a decrease in the ability to recover from loss of balance (20-24).

The better performance, in this study, among elderly people with higher levels of physical activity practice obtained in stabilometric and functional tests may be partly attributed to the benefits arising from the morphological and neuromuscular adaptations of physical training, responsible for a less pronounced decline in these motor skills. The literature has shown that physical exercise has a positive effect on brain and cognitive health, bringing benefits with regard to neural functioning, increased neuronal metabolism, improved cognition and brain structures and functions, balance, muscle strength, and functional capacity (25).

Regarding the functional tests, TUG and OST, we did not find significant differences between elderly people with different levels of usual practice of physical activity. Although our results do not corroborate those found on the platform, retrospective studies show that the locomotion speed among elderly people may be an accurate parameter for identifying those at risk of falls (26).

Therefore, the time spent to perform the TUG test, for instance, is directly associated to the functional mobility level and, perhaps, to the risk of falls. Decreased time to complete the test indicates independent elderly people with regard to mobility, but, on the other hand, times greater than 20 s tend to identify more dependent elderly people with regard to daily tasks and the risk of falls (27).

Failure to obtain significant results among the groups with regard to TUG may be related to the categorization of results. The literature shows different scores for classifying the elderly people with regard to their mobility. A study suggested a cutoff value ≥ 20 s (28), another one recommended a cutoff value of 14 s for independent elderly people (29), and a cutoff value of 10 s has also been proposed (30).

In short, although this study was not able to identify which domain of physical activity would lead to a significant impact on the stabilographic parameters and neuromotor tests, it brought as a contribution the importance of adequate levels of usual practice of physical activity for a good body stability, with a consequent lower risk to falls.

We point out the importance of further studies able to reduce the bias inherent to the fact that all individuals evaluated here were women; it is important to gather probability samples more balanced with regard to the representation of both sexes and the stratification mode of the physical activity level, which may be measured more accurately by means of instruments with greater validity, reliability, practicality, and non-reactivity.

Conclusion

According to the study results, it was shown that the level of physical activity practice among elderly women improves the body stability quantified by stabilometry, a fact not shown in the neuromotor tests, which did not detect statistically significant differences between the levels of physical activity practice and the scores of OST with open and closed eyes.

References

1. Ramos LR. A saúde do idoso no Brasil – uma visão clínico-epidemiológica [Tese de livre-docência]. São Paulo: Universidade Federal de São Paulo; 1997.

2. Costa MFL, Veras R. Saúde pública e envelhecimento. Cad Saúde Pública. 2003;19(3):700-1.

3. Kirkwood TB. Evolution of ageing. Mech Ageing Dev. 2002;123(7):737-45.

4. Lord SR, Sherrington C, Menz HB. Falls in older people: risk factors and strategies for prevention. New York: Cambridge University press; 2001.

5. Hsiao H, Simeonov P. Preventing falls from roofs: a critical review. Ergonomics. 2001;44(5):537-61.

6. Du Pasquier RA, Blanc Y, Sinnreich M, Landis T, Burkhard P, Vingerhoets FJ. The effect of aging on postural stability: a cross sectional and longitudinal study. Neurophysiol Clin. 2003;33(5):213-8.

7. Carter ND, Kannus P, Khan KM. Exercise in the prevention of falls in older people: a systematic literature review examining the rationale and the evidence. Sports Med. 2001;31(6):427-38.

8. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. 2007;39(8):1423-34.

9. Benedetti TB, Antunes PC, Anez CRR, Mazo GZ, Petroski EL. Reprodutibilidade e validade do questionário internacional de atividade física (IPAQ) em homens idosos. Rev Bras Med Esporte. 2007;13(1):11-6.

10. Alfieri FM, Werner A, Roschel AB, Melo FC, Santos KLS. Mobilidade funcional de idosos ativos e sedentários versus adultos sedentários. Braz J Biomotricity. 2009;3(1):89-94.

11. Binder EF, Schechtman KB, Ehsani AA, Steger-May K, Brown M, Sinacore DR, et al. Effects of exercise training on frailty in community-dwelling older adults: results of a randomized, controlled trial. J Am Geriatr Soc. 2002;50(12):1921-8.

12. Carvalho R, Vasconcelos O, Gonçalves P, Conceição F, Vilas-Boas JP. The effects of physical activity in the anticipatory postural adjustments in elderly people. Motor Control. 2010;14(3):371-9.

13. Podsiadlo D, Richardson S. The timed “Up & Go”: a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39(2):142-8.

14. Gustafson AS, Noaksson L, Kronhed AC, Moller M, Moller C. Changes in balance performance in physically active elderly people aged 73-80. Scand J Rehabil Med. 2000;32(4):168-72.

15. Matsudo SMM. Avaliação do idoso: física e funcional. São Caetano do Sul: Midiograf; 2001.

16. Brach JS, van Swearingen JM, Newman AB, Kriska AM. Identifying early decline of physical function in community-dwelling older women: performance-based and self-report measures. Phys Ther. 2002;82(4):320-8.

17. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA. 1995;273(5):402-7.

18. Oliveira RF, Matsudo SMM, Andrade DR, Matsudo VKR. Efeitos do treinamento de Tai Chi Chuan na aptidão física de mulheres adultas e sedentárias. Rev Bras Ciên e Mov. 2001;9(3):15-22.

19. Choy NL, Brauer S, Nitz J .Changes in postural stability in women aged 20 to 80 years. J Gerontol A Biol Sci Med Sci.2003;58 (6): 525-30.

20. Fujita T, Nakamura S, Ohue M, Fujii Y, Miyauchi A, Tagagi Y, et al. Effect of age on body sway assessed by computerized posturography. J Bone Miner Metab. 2005;23(2):152-6.

21. Bernhardi MR. Envejecimento: cambios bioquímicos y funcionales del Sistema Nervioso Central. Rev chil neuro-psiquiatr. 2005;43(4):297-304.

22. Deschenes MR. Effects of aging on muscle fibre type and size. Sports Med. 2004;34(12):809-24.

23. Hunter GR, McCarthy JP, Bamman MM. Effects of resistance training on older adults. Sports Med. 2004;34:330-48.

24. Baloh RW, Ying SH, Jacobson KM. A longitudinal study of gait and balance dysfunction in normal older people. Arch Neurol. 2003;60(6):835-9.

25. Kramer AF, Erickson KI, Colcombe SJ. Exercise, cognition, and the aging brain. J Appl Physiol. 2006;101(4):1237-42.

26. Hollman JH, Youdas JW, Lanzino DJ. Gender differences in dual task gait performance in older adults. Am J Mens Helth. 2011;5(1):11-7.

27. Worsfold C, Simpson JM. Sttandardisation of a Three-metre Walking Test for Elderly People. Physiother.2001;87(3):125-32.

28. Shumway-Cook A, Brauer S, Woolacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther. 2000;80(9):896-903.

29. Wall JC, Bell C, Campbell S, Davis J. The Timed Get-up-and-Go test revisited: measurement of the component tasks. J Rehabil Res Dev. 2000;37(1):109-14.

Received: 03/18/2012
Recebido: 18/03/2012

Approved: 03/13/2013
Aprovado: 13/03/2013